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METHOD FOR PRODUCING STERILIZATION DEVICE FOR WATER-PURIFIER USE
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SPECIFICATION

54. Title

METHOD FOR PRODUCING STERILIZATION DEVICE FOR WATER-PURIFIER USE

57. Claims

1. A method for producing a sterilization device for water-purifier use, said method comprising applying a resin adhesive onto a substrate, attaching hardly-soluble silver-salt particles having a sterilization effect onto it before this resin adhesive is hardened, applying a pressure to the aforesaid hardly-soluble silver-salt particles so as to push them into the aforesaid resin adhesive, and subsequently hardening the aforesaid resin adhesive, thereby bonding the aforesaid hardly-soluble silver-salt particles to the substrate.

[Detailed Description of the Invention]

The object of the present invention is to add a sterilization function to commercially available water purifiers. More specifically, it intends to sterilize filtered water that is obtained by eliminating chlorine gas, bleaching powder, and the like contained in cities' tap water with active carbon in water purifiers. In particular, it intends to impart a sterilization function to water purifiers with the use of a silver salt that is hardly soluble in water--for example, silver chloride, silver bromide, or silver iodide.

None of the water purifiers that are currently available on the market has a sterilization function. However, when the intended purpose of tap water is considered, with currently available water

purifiers, the infestation of common germs and coliform bacteria could occur in the filtered-water section of water purifiers as a result of careless handling because filtered water, which results from eliminating chlorine and bleaching powder with active carbon, does not have a sterilizing ability. In view of this danger of bacterial contamination, there is a need for providing a sterilization device for commercially available water purifiers. There are various disinfectants that can be used for water, but, considering the intended purpose of water purifiers, they should not affect the taste of water, and silver salts that are hardly soluble in water are considered suitable. From the standpoint of the solubility of silver salts, silver chloride (solubility in water: 10^{-5} mol/L), silver bromide (solubility in water: 10^{-6} mol/L), and silver iodide (solubility in water: 10^{-8} mol/L) are selected, and the case of using silver chloride is described in the following.

As conceivable ways to add a sterilizing ability to household-use water purifiers, there are a method of mixing silver chloride powder into active carbon and a method of adsorbing silver chloride to active carbon. These methods, however, have various disadvantages. Namely, in the case of a water purifier in which a filter fabric containing powdered active carbon and a water-collecting pipe are integrated into one piece, there are the following disadvantages.

(1) The active carbon particles other than those that are effectively precoated onto the surface of the filter fabric

precipitate to the bottom of the cartridge having the filter fabric layer, and the silver chloride that is adsorbed to or mixed with the precipitated active carbon is scarcely utilized.

(2) Active carbon has an absolute specific gravity of 2.0 and an apparent specific gravity of approximately 0.20, while the absolute specific gravity of silver chloride is 5. Due to this substantial difference in their specific gravities, silver chloride powder separates from active carbon and precipitates to the bottom of the cartridge having the filter fabric layer, which fact translates into poor utilization of silver chloride. In addition, it is difficult to dissolve out Ag^+ ions constantly in an amount that is necessary to sterilize germs.

(3) Even if active carbon containing silver chloride is uniformly precoated over the surface of the filter fabric layer, because the quantity of Ag^+ ions that are initially dissolved out is large, there is a tendency for the quantity of dissolved Ag^+ ions to rapidly decrease with use. There are two conceivable causes for this. One is that the surface of active carbon is precoated with foreign matter, and this contamination causes the reduction of dissolved Ag^+ ions. The other is that adsorbing silver chloride in a thick layer to the surface of active carbon causes the capability of the active carbon proper to deteriorate, thus rendering it unusable for water purifiers. Even if it is adsorbed thinly, the ions are dissolved out in a large

quantity initially, and silver chloride could run out before the life of the active carbon.

(4) It is extremely difficult to check the degree of adsorption of active carbon for the purpose of quality control.

(5) There is a conceivable danger that minute silver chloride particles flow into the filtered water in a colloidal form and are ingested by human beings.

(6) Household-use water purifiers do not need to have a disinfectant inserted into it on the active-carbon side of the filter fabric, that is, the water-source side, for a sterilization purpose because chlorine or bleaching powder is present on that side. Infestation of germs occurs on the water collecting side inside cities [sic] through which the filtered water passes.

Considering the aforesaid characteristics of silver chloride and the structure of water purifiers, the present invention provides a method for producing a sterilization device that sterilizes germs when installed on the filtered-water side (or in the vicinity of the water-collecting pipe in the filter fabric if the filter fabric and the water-collecting pipe are constructed in one piece) of a commercially available water purifier, thus rendering it useful for water purifiers.

The following explains one embodiment of the present invention in concrete terms, referring to figures.

In the figures, reference numeral 1 indicates a sealed cylindrical case, which is composed of a case proper (2) and a lid (3).

At the bottom of the case proper (1) is formed an inflow hole (4) that connects to a water line, and a faucet (5) is provided at the center of the lid (3) in a rotatable manner. Reference numeral 6 indicates a cartridge that is housed in the case (1). It is made from a synthetic resin and formed in a cylindrical shape, and it has ports (7, 7) at its under surface. There is a space (8) provided between this cartridge (6) and the case (1). Reference numeral 9 indicates a filtering body that is housed inside the cartridge (6), and it is constructed by wrapping a coarsely meshed porous resin frame (10) that is formed in a long rectangular shape with a filter fabric made of a close-grained cloth comprised of resin fibers and by sealing the opening with a resin adhesive. At the center of this filtering body (9) is inserted the lower portion of a resin-made water-collecting pipe (12), and the portion of the water-collecting pipe (12) that is positioned inside the filtering body (9) has a large number of water-collecting holes (13). This filtering body (9) is housed in a serpentinely bent condition, as shown in Fig. 2, inside the cartridge (6). The top end of the water-collecting pipe (12) runs through the cartridge (6) and connects to the faucet (5). Reference numeral 14 indicates active carbon powder that is placed inside the cartridge (6). Reference numeral 15 indicates a seal for closing the ports (7, 7) so as to prevent the active carbon powder (14) from leaking out from the cartridge (6). It normally has the same property as that of common paper, but, once it is wetted with water, it dissolves in a few

seconds. Reference numeral 16 indicates an air vent hole that is provided at the top part of the case (1); 17, its plug; 18, an air vent hole that is provided at the top of the cartridge (6); and 19, a filter that seals air vent hole 18. This filter has a porosity that allows air and water to pass through it but does not allow the active carbon powder (14) to pass through. Reference numeral 20 indicates a film-shaped sterilization device that is prepared by bonding hardly-soluble silver-salt particles as the disinfectant to a substrate by means of an adhesive, and it is inserted into some part of the resin-made frame (10). This sterilization device (20) is, as shown in Fig. 6e, a film-shaped device that is prepared by bonding hardly-soluble silver salt particles (23) to a flexible substrate (21) by means of a resin adhesive (22). It is configured in such a way that the hardly-soluble silver-salt particles (23) that are bonded by means of the resin adhesive (22) are exposed to the surface so as to make contact with filtered water.

The following explains the operation of the water purifier thus configured. When water is supplied through the inflow hole (4) from a water line, the water-soluble seals (15, 15) are dissolved, thus opening the ports (7, 7). As a result, the tap water enters the cartridge (8 [sic]) through the ports (7, 7) and stirs the active carbon powder (14) and subsequently precoats the external surface of the filtering body (9) with the active carbon powder (14) as the water flows into the filtering body (9), thereby forming an active carbon

powder layer on the external surface of the filtering body (9). As a result, the tap water is filtered by the active carbon powder layer (14), thus eliminating bleaching powder, chlorine gas, etc., contained in the water. The water, after being filtered, passes inside the filtering body (9) and is collected at the portion of the water-collecting pipe (12) where there are water-collecting holes (13), after which the water flows through the water-collecting pipe (12) and is supplied to the outside from the faucet (5). Meanwhile, the hardly-soluble silver-salt particles of the sterilization device that is placed inside the filtering body (9) in an area near the water-collecting pipe (12) and in other areas as necessary dissolve gradually into the water, and the resulting Ag^+ ions perform sterilization inside the water purifier. As a result, the possibility of infestation of germs inside the water purifier can be eliminated. A water purifier in which was embedded this sterilization device prepared by bonding hardly-soluble silver salt particles by means of resin adhesive was actually installed in an up/down passage [sic], and the content of the Ag^+ ions in the initial fraction of the filtered water was measured after the passage of 24 hours and found to be 45 ppb. Into this filtered water in which these Ag^+ ions were present, coli bacteria (Escherichia Coli K-IZ-A) whose concentration was adjusted to 6×10^8 cells/mL were added. It was confirmed that the coli bacteria were killed completely within 6 hours of the addition.

The following explains the sterilization device of the present invention used for water purifiers. This sterilization device is produced as shown in Figs. 6 a through e. More specifically, an adhesive (22) is applied to the surface of a flexible resin substrate (21), such as Mylar film, etc., having a thickness of 80 µ or thereabouts by common screen printing. As the adhesive (22), epoxy resin adhesives are used, but it goes without saying that, besides these, any adhesive can be used as long as it exhibits good affinity with the flexible resin substrate to be used. The application of the adhesive (22) is accomplished by roller printing or brush coating. The epoxy resin adhesive (22) used here is composed of 42 g Epicoat 828 (a product name), 18 g Adeca Resin EP-4000 (a product name), and 40 g Epomate B-002 (a product name). Next, silver chloride particles (23) are sprinkled over the aforesaid adhesive (22), and, using a Mylar film (24) and a pressure roller (25), the aforesaid silver chloride particles (23) are pushed into the aforesaid adhesive (22), thus attaching the aforesaid silver chloride particles (23) to the resin adhesive by pressure. Thereafter, excess silver chloride particles (23) are eliminated by applying vibration to them, and the adhesive is hardened at 100 °C for 2 hours, thereby bonding the silver chloride particles (23) securely. With respect to these hardening conditions, if the resin adhesive (22) is a normal-temperature hardening type, heating is not required. Thereafter, the weakly-bonded silver chloride particles, that is, the silver chloride particles that have not been

held with the adhesive, are eliminated forcefully, using a wire brush (not shown in the figures). In a sterilization device (20) that was obtained in this manner, silver chloride particles were bonded at a rate of 0.012 g/cm^2 or thereabouts. The bonding rate of the silver chloride particles (23) can be easily controlled by controlling the thickness of the resin adhesive (22) and the particle size of the silver chloride particles (23). This, however, is not related much to the after-mentioned quantity of silver dissolved from silver chloride and is not an important issue in production. This sterilization device was cut into various sizes and attached to the resin-made frame (10) of the filtering body (9) of a water purifier, and the quantity of the dissolved Ag^+ ions was measured. The following table shows the quantity of the Ag^+ ions dissolved out from the sterilization device of each size as a function of time.

Dissolving Time (hr)	AgCl Attached Area (cm^2)	Absolute Quantity (g) of Attached AgCl	Quantity (ppb) of Dissolved Ag^+ Ions
3	18	0.243	45
8	18	0.243	45
15	18	0.243	45
15	9	0.120	45
15	32	0.425	45
15	90	1.200	45

The quantity of dissolved Ag^+ ions was measured by atomic absorption analysis, using an atomic absorption analyzer manufactured by Beckman Co.

In the aforesaid embodiment, silver chloride particles as the disinfectant were bonded on one side of a substrate by means of an

adhesive, but it goes without saying that they can be bonded on both sides of a substrate in the same manner.

As is evident from the explanation in the foregoing, according to the present invention, hardly-soluble silver-salt particles are bonded to a substrate with the use of an adhesive; therefore, the hardly-soluble silver-salt particles can be held by the substrate securely. Consequently, a sterilization device that is made according to this method does not have the problem of separation of hardly-soluble silver-salt particles caused by water pressure, etc., when it is housed inside a water purifier. Furthermore, it can eliminate the problem of peeling completely, compared with devices obtained by vapor deposition, etc.

Compared with the method of mixing a silver salt with active carbon, the present invention can provide a sterilization device that yields a stable quantity of dissolved Ag^+ ions. Since this device is produced by forming a layer of an adhesive on a substrate, sprinkling hardly-soluble silver-salt particles over it, and by applying a pressure so as to push them into the adhesive layer, it is extremely easy to form a layer of silver-salt particles on the surface of the adhesive layer. It is also possible to prevent the hardly-soluble silver-salt particles from being completely buried in the adhesive layer by selecting the applied pressure; therefore, the silver salt can be utilized highly effectively.

[Brief Explanation of the Drawings]

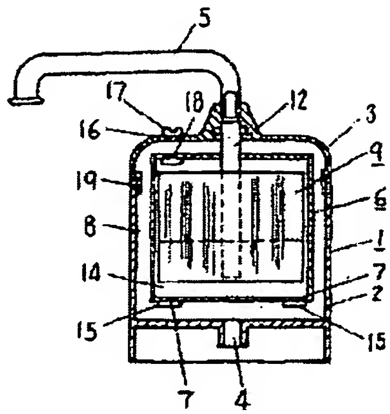
Fig. 1 is a cross-sectional drawing of the water purifier pertaining to the present invention. Fig. 2 is a perspective view of the filtering body of the aforesaid water purifier. Fig. 3 is a center-section drawing of the filtering body. Figs. 4 and 5 are an enlarged plan view and enlarged cross-sectional view, respectively, of the filtering body for illustrating the way the sterilization device is installed. Figs. 6 a through e are drawings for explaining the method for producing the sterilization device for water-purifier use that is one embodiment of the present invention.

20 … sterilization device, 21 … substrate, 22 … resin adhesive, 23 ... hardly-soluble silver-salt particles.

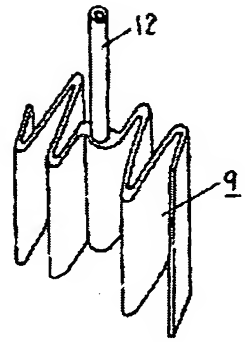
56. Cited Literature

United States Patent No. 3,327,859

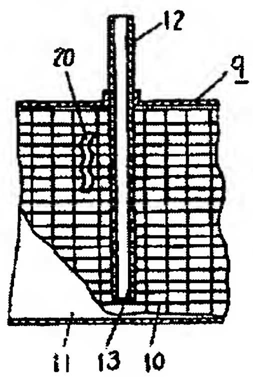
[FIG. 1]



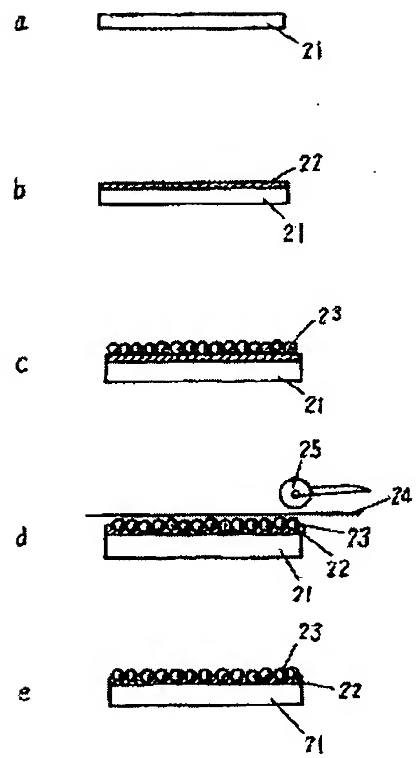
[FIG. 2]



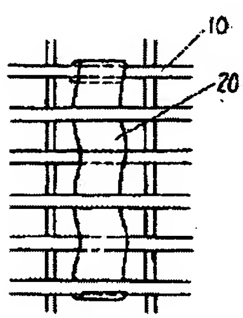
[FIG. 3]



[FIG. 6]



[FIG. 4]



[FIG. 5]